TABLE VIII.—*Heights of rivers above zeros of gauges*—Continued.

| Stations. | Distance to mouth of river. | Danger-line on gauge. | Highest water. | | Lowest water. | | Mean stage. | Monthly range. |
|---|---|---|---|---|---|---|---|---|
| | | | Height. | Date. | Height. | Date. | | |
| | *Miles.* | *Feet.* | *Feet.* | | *Feet.* | | *Feet.* | *Feet.* |
| *Great Kanawha River.* | | | | | | | | |
| Charleston, W. Va | 61 | 30 | 11.6 | 1 | 3.1 | 29 | 6.1 | 8.5 |
| *New River.* | | | | | | | | |
| Hinton, W. Va | 95 | 14 | 6.3 | 1 | 1.3 | 27-29 | 2.7 | 5.0 |
| *Licking River.* | | | | | | | | |
| Falmouth, Ky | 30 | 25 | 8.0 | 1 | 2.4 | 21-25, 29-31 | 3.4 | 5.6 |
| *Miami River.* | | | | | | | | |
| Dayton, Ohio | 69 | 18 | 3.9 | 16 | 1.1 | 2 | 2.1 | 2.8 |
| *Monongahela River.* | | | | | | | | |
| Weston, W. Va | 161 | 18 | 6.9 | 9 | − 0.3 | 27-29 | 0.7 | 7.2 |
| Fairmont, W. Va | 119 | 25 | 8.6 | 10 | 1.1 | 8 | 2.5 | 7.5 |
| Morgantown, W. Va | 95 | 20 | 13.3 | 10 | 7.4 | 28-30 | 8.6 | 5.8 |
| Greensboro, Pa | 81 | 18 | 13.0 | 10 | 7.5 | 28-31 | 8.6 | 5.5 |
| Lock No. 4, Pa | 40 | 28 | 15.0 | 11 | 7.1 | 27-30 | 9.0 | 7.9 |
| *Cheat River.* | | | | | | | | |
| Rowlesburg, W. Va | 36 | 14 | 6.0 | 9 | 2.8 | 28-31 | 3.5 | 3.2 |
| *Youghiogheny River.* | | | | | | | | |
| Confluence, Pa | 59 | 10 | 3.7 | 1 | 1.3 | 29 | 2.1 | 2.4 |
| West Newton, Pa | 15 | 23 | 4.7 | 10 | 0.5 | 29 | 1.6 | 4.2 |
| *Tennessee River.* | | | | | | | | |
| Knoxville, Tenn | 614 | 29 | 10.0 | 1 | 0.9 | 30-31 | 2.1 | 9.1 |
| Chattanooga, Tenn | 430 | 33 | 13.9 | 3 | 2.5 | 31 | 5.3 | 11.4 |
| Bridgeport, Ala | 390 | .. ... | 10.9 | 3 | 1.2 | 31 | 3.6 | 9.7 |
| Florence, Ala | 220 | 16 | 8.9 | 5 | 1.3 | 31 | 3.8 | 7.6 |
| Johnsonville, Tenn | 94 | 21 | 12.4 | 6 | 3.1 | 29,31 | 6.7 | 9.3 |
| *Wabash River.* | | | | | | | | |
| Terre Haute, Ind [c] | 165 | 16 | 5.1 | 20 | 1.7 | 30,31 | 3.0 | 3.4 |
| Mt. Carmel, Ill | 50 | 15 | 9.1 | 1 | 3.0 | 31 | 5.3 | 6.1 |
| *Red River* | | | | | | | | |
| Arthur City, Tex | 688 | 27 | 11.0 | 3 | 2.6 | 28-31 | 4.6 | 8.4 |
| Fulton, Ark | 565 | 28 | 11.7 | 1 | 1.2 | 30,31 | 4.0 | 10.5 |
| Shreveport, La | 449 | 29 | 4.0 | 5 | − 1.9 | 1 | 0.6 | 5.9 |
| Alexandria, La | 139 | 33 | 4.4 | 10 | − 1.2 | 31 | 1.6 | 5.6 |
| *Atchafalaya River.* | | | | | | | | |
| Melville, La | 100* | 31 | 18.7 | 16 | 10.5 | 1 | 14.6 | 8.2 |
| *Ouachita River.* | | | | | | | | |
| Camden, Ark | 340 | 39 | 15.0 | 1 | 4.1 | 31 | 6.3 | 10.9 |
| Monroe, La | 100 | 40 | 15.7 | 5 | 2.9 | 30,31 | 7.9 | 12.8 |
| *Yazoo River.* | | | | | | | | |
| Yazoo City, Miss | 80 | 25 | 3.6 | 9-11 | − 1.8 | 30,31 | 2.0 | 5.4 |
| *Cape Fear River.* | | | | | | | | |
| Fayetteville, N. C | 100 | 38 | 15.4 | 2 | 4.8 | 30 | 9.0 | 10.6 |
| *Congaree River.* | | | | | | | | |
| Columbia, S. C | 37 | 15 | 4.6 | 2 | 0.5 | 28,29 | 2.4 | 4.1 |
| *James River.* | | | | | | | | |
| Lynchburg, Va | 257 | 18 | 5.5 | 1 | 0.4 | 27,28 | 1.4 | 5.1 |
| *Alabama River.* | | | | | | | | |
| Montgomery, Ala | 265 | 35 | 6.4 | 5 | 0.5 | 31 | 2.2 | 5.9 |
| *Coosa River.* | | | | | | | | |
| Rome, Ga | 225 | 30 | 6.0 | 1 | 1.0 | 30,31 | 2.1 | 5.0 |
| *Tombigbee River.* | | | | | | | | |
| Columbus, Miss | 285 | 33 | − 0.1 | 6 | − 2.9 | 28,29 | −1.9 | 2.8 |
| Demopolis, Ala | 155 | 35 | 6.9 | 4 | − 0.7 | 31 | 1.7 | 7.6 |
| *Black Warrior River.* | | | | | | | | |
| Tuscaloosa, Ala | 90 | 38 | 7.7 | 1 | 0.5 | 29-31 | 1.7 | 7.2 |
| *Savannah River.* | | | | | | | | |
| Augusta, Ga | 130 | 32 | 17.6 | 16 | 5.8 | 31 | 9.8 | 11.8 |
| *Susquehanna River.* | | | | | | | | |
| Harrisburg, Pa | 70 | 17 | 4.2 | 14 | 1.3 | 29 | 2.7 | 2.9 |
| *W. Br. of Susquehanna.* | | | | | | | | |
| Williamsport, Pa | 35 | 20 | 5.0 | 11 | 1.3 | 29 | 2.8 | 3.7 |
| *Sacramento River.* | | | | | | | | |
| Redbluff, Cal | 241 | 23 | 20.6 | 15 | 3.6 | 1 | 8.1 | 17.0 |
| Sacramento, Cal | 70 | 28 | 17.6 | 31 | 13.6 | 12,13 | 15.8 | 4.0 |
| *Willamette River.* | | | | | | | | |
| Albany, Oreg | 99 | 20 | 18.0 | 15 | 5.2 | 26 | 9.2 | 12.8 |
| Portland, Oreg | 10 | 15 | 14.2 | 15 | 5.5 | 2 | 9.2 | 8.7 |

* Distance to the Gulf of Mexico. † Frozen throughout the month. [a] Frozen 5-16 and 21-31. [b] Frozen 3-8. [c] Frozen 25-29.

## SPECIAL CONTRIBUTIONS.

### EQUIPMENT OF AN AERO-PHYSICAL OBSERVATORY.

By ALEXANDER MCADIE, Local Forecast Official, San Francisco, Cal.

In response to a request by the Editor, Mr. McAdie has kindly allowed the WEATHER REVIEW to publish, in advance, the following extract from a paper submitted by him in 1894 to the Secretary of the Smithsonian Institution, in competition for the Hodgkin's Prizes. The use of the kite, the aero-plane, and the aero-motor, which has so greatly developed since that time, suggests, as Mr. McAdie states, a still further addition to the equipment. He also suggests that the magnetic outfit and the seismographic apparatus would be an appropriate addition, although rather outside of the direct line of atmospheric investigation. The list of instrumental equipment is as follows:

EQUIPMENT OF AN AERO-PHYSICAL OBSERVATORY.

BAROMETRY.

Standard barometers—Wild-Fuess, Fortin, Kew, United States Weather Bureau Standard.
Multiplying barographs—Richard, Marvin, Draper.
Aneroids—Redier or improved Hicks.
Statoscope for recording minute fluctuations of pressure, especially valuable during thunderstorms and gusts.
Sundell normal barometer.
Telebarometers, distant from each other not less than 1,000 feet in a horizontal direction and 500 feet in a vertical direction. This implies that the laboratory must be situated on the summit of a hill or mountain, with base stations. Buchan, in his résumé of the work done at Ben Nevis, intimates that some very important relations are thus discoverable.

THERMOMETRY AND HYGROMETRY.

Standard types of thermometers—exposed, wet bulb, maximum and minimum, water and soil.
Thermographs and self-registering psychrometers.
Assmann aspiration psychrometer.
Telethermographs and telehygrographs.
Fog indicators.

INSOLATION.

Actinometer (Schwolson.)
Langley's bolometer, with appropriate galvanometers for the exploration and mapping of the solar spectrum, particularly the infra-red portion.
Photographic records of the more prominent absorption lines due to aqueous vapor in the atmosphere, and comparison, after proper scale determination, with the intensity of standard solar lines with the ultimate aim of ascertaining the distribution of vapor in the atmosphere at various altitudes and variations therefrom.
Spectroheliograph. A good 12 or 14 inch photographic objective for investigating the relations of solar spots, faculæ and prominences.

NEPHOSCOPY AND PLUVIOMETRY.

Sunshine recorders of various types.
Nephoscopes and Pole star recorders.
Rain gauges and evaporometers.

ATMIDOMETRY.

Barus's device for showing colors of cloudy condensation.
Aitken's dust counter or coniscope.
The determination of the amount of haze or smoke present in the atmosphere is now quite neglected in meteorology, although a matter of very considerable importance to health. We should have daily records of the relative purity of the atmosphere.

ANEMOMETRY.

Anemoscopes.
Anemo-cinemograph—an instrument showing the varying force exerted by the wind, preferable to the old form of anemograph; and yet some further improvement looking to a fuller recognition of what has been termed "the internal work of the wind" is desirable.
Helicoid anemometer.
Clino-anemometer, or instrument for registering currents not horizontal.
Wind pressure gauge and suction anemometer.

THERMODYNAMICS AND CHEMISTRY.

Apparatus might be devised which would give graphically the thermodynamic conditions of the atmosphere. The volume, pressure, temperature, and density of the air being known, we ought to be able to follow the isotherms and adiabatics through the varying conditions in cyclone and anticyclone at all levels. Thus Hertz has given the adiabatics for the dry, rain, and hail stadia, and it is practicable to follow a given air mass through the varying thermodynamic conditions.

ELECTROMETRY.

Proper apparatus for measurements in atmospheric electricity.

Mascart-Kelvin electrometers for the determination of the potential of the air. The type of voltmeter known as the multiple quadrant electrometeter, or substantially Lord Kelvin's air Leyden, should be installed with an automatic register for continuous records of the electrification of the air.

Elster and Geitel's apparatus, modified, for records of the air "leakage" of electrical charge under the influence of ultra-violet light.

Brontometer, for use in the study of the strains and stresses in air between highly electrified clouds or cloud and earth. The name brontometer is used, but some more appropriate type of instrument than the present is desired. It now gives the time of each lightning flash, the duration of thunder, the changes in direction and force of the wind, in temperature, humidity, and barometric pressure during a thunderstorm; but there is wanting the photographic auxiliaries to delineate the character of each discharge. The true character in space and the dimensions of the discharge are determinable by such means. The potential fluctuations added to such data will enable us to study the strains and ruptures in the atmosphere after the thunderstorm as completely as a plate of fractured armor can be sthdied after a test.

PHYSIOLOGY AND BIOLOGY.

The known properties of atmospheric air are clearly of great importance in all physiological and biological research. In the latter, atmospheric environment must be an effective factor in the variation of species, and in the former, at the very outset, do we not meet an intimate relation between the irritability of nerve and muscle and atmospheric conditions? How important to know the atmospheric conditions as influencing exhilaration and fatigue. The so-called "sensible" temperature, for example, enables one to live in the temperatures of the Northwest in winter, and renders temperatures higher by 30° elsewhere unbearable.

Such a laboratory, then, studying the properties of atmospheric air, would, we firmly believe, influence research in every department of applied science. In agriculture the value is apparent; in economics, history, hygiene, botany, geology, and biology questions now unanswered would be disposed of. In that much-dreamed-of consummation, the conquest of the air, when transportation shall be by air ships and communication by air runners or disturbances of the electrified air, the contributions to knowledge from such a laboratory would be incessant and without price. Aye, in directions now unthought of, the aero-physicist would push onward in the great region now unexplored.

## SUNSTROKE IN CALIFORNIA AND ARIZONA.

By W. F. R. PHILLIPS, M. D., in charge of Section of Climatology.

The topic for this paper was evolved from the statistics collected when investigating the sunstrokes of August, 1896, a report on which was published in the MONTHLY WEATHER REVIEW for November, 1896.

During a considerable part of the month of July, 1896, the Pacific States suffered from a somewhat protracted spell of hot weather, during which, as will hereinafter appear, a number of cases of sunstroke occurred. The importance of this latter fact subsists in the peculiar reputation that the climate in general of this region has all along borne in respect to sunstroke. It is popularly supposed that sunstroke in the dry and hot climates of Arizona and California, and of the Cordilleran Region in general, is an extremely rare occurrence; indeed the statement is occasionally made that it never occurs in them.

Hirsch, in his magnificent work on geographical and historical pathology (Handbook of Geographical and Historical Pathology, Vol. III, 1886), expresses the current opinion of the day as to the freedom of the Trans-Rocky Mountain Region from sunstroke. He says:

In remarkable contrast to the frequency of the seizure in those parts of the North American Continent of which we have spoken heretofore [the Atlantic Seaboard and Central States], is the comparative immunity of the Pacific Coast. According to Blake and Gibbons there was hardly anything heard of sunstroke among the gold diggers in California.

The care, patience and labor with which Hirsch collected statistics, and the conservatism and ability with which he compiled and discussed them, give to his statements great authority. How far the reputation of the Pacific Region for immunity from sunstroke may rest upon the currency of any of these statements it is not the object of the writer to discuss. It is, however, proper to observe that the authorities, Blake and Gibbons, upon whom Hirsch rested his statement as to the frequency of sunstroke in the Pacific Region, wrote, respectively, in 1852 and in 1857, when this vast region was but beginning to have a population, and when (considering the peculiar circumstances and excitement attending the rush of people to the gold fields) it is highly probable that little attention was paid to careful registration of statistics regarding disease and its correlated phenomena.

The census of 1850 gave California a population of 92,597; in 1860 the population of Arizona, then a county of the territory of New Mexico, was given as 6,482. To-day California has more than 1,200,000, and Arizona, perhaps, more than 60,000 inhabitants. The populations of the other states and territories comprised in the Cordilleran Region have also increased greatly since Blake and Gibbons wrote.

In weighing the statements concerning the climatology of this region by early writers, we should take into consideration the sparsely settled condition of the country, the character and mode of life of its earlier settlers, the virginity of the soil and its freedom from the contaminations that accompany density of population, the lack of means of ready communication and the probable want of system in recording and registering the facts pertaining to the medical climatology of the country.

As relevant to the special subject of this paper the following extracts from two California journals are taken from issues just prior to the termination of the very hot weather previously referred to:

All over the great interior valleys of California men and women have succumbed to the terrible heat of the fire month. Fresno, Merced, Bakersfield, Stockton, Sacramento, Los Angeles, San Bernardino, Riverside, and many other towns have furnished victims for the prostrating solar rays. * * * The heat was not greater than has often been encountered before, but the atmosphere lacked that dryness which has always been the pride of California, and as a result thermic fever has claimed its victims by scores. * * * So thoroughly grounded in the old practitioner is the belief that in California "neither hydrophobia nor sunstroke" is ever encountered, that it is only after the most indubitable evidence that we can be persuaded to call the dread heat stroke by its proper name.—*San Francisco Examiner, July* 26, 1896.

The heated term commenced July 3 and lasted nineteen days. The first victim was J. Pellegrini, a laborer on the Valley road, who died at Herndon. Joe Toma, an employee at the City Bakery, succumbed to the heat a few days later. Then came in rapid succession the deaths of Lena Johnson, of Easton, John Stokes, and James Downing.

Such a record has never occurred in the history of Fresno, even in the hottest summers. The usual percentage of sunstroke cases in the country is so small that it is not worth consideration. * * * Weather Observer Bolton says that a striking feature of the three weeks' spell was the number of warm nights. Usually there are only about three nights in July when it is difficult to obtain sleep, the temperature usually falling to 60° with a refreshing breeze. In the past three weeks, however, a temperature of 75° and upward was noted on nearly every night from the 4th to 13th, inclusive. * * * the humidity was also higher than for eight years past, being as high as 55 to 65 per cent in the mornings.—*Fresno Daily Evening Expositor, July* 24, 1896.

The following statistics of sunstroke in California and Arizona were obtained in response to the circular issued by the Chief of the Weather Bureau, August 20, 1896:

| | | | |
|---|---|---|---|
| Phœnix, Ariz ....... | 6 | deaths from sunstroke. | |
| Fresno, Cal ......... | 4 | " " " | |
| San Luis Obispo, Cal. | 1 | " " " | |
| Red Bluff, Cal ....... | 1 | " " " | 5 cases recovered. |
| Total ........... | 12 | | 5 |

Total events 17.